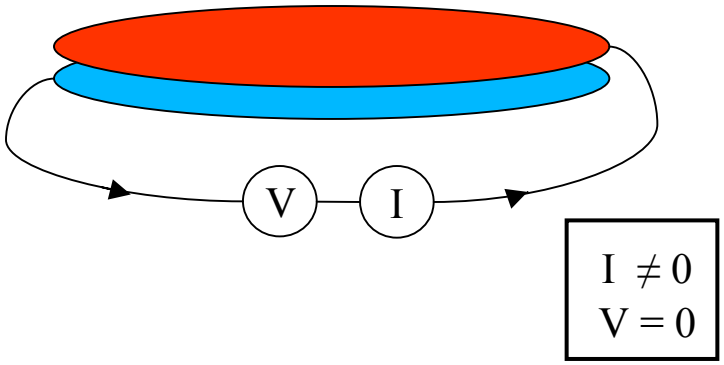
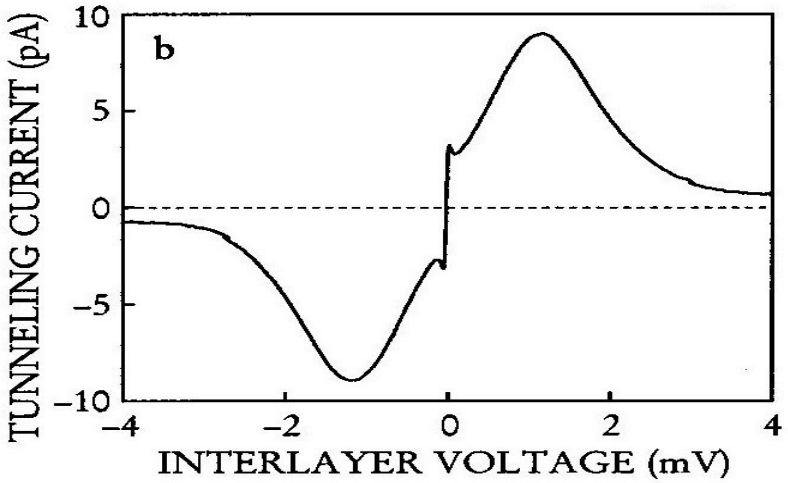
Simulation Studies of "Josephson Tunneling" in Quantum Hall Bilayers





From Spielman et al., PRL 2000

- Interlayer tunneling experiments reveal a sharp zero bias tunneling resonance for bilayer quantum Hall systems. This is thought to be a quantum Hall analog of the Josephson effect.
- Dissipation persists at very low interlayer bias even at very low temperature. What are the low energy excitations responsible for this? What causes the breakdown of the resonance as the tunneling current increases?
- Investigated this within the *resistively shunted Josephson junction model* using a Langevin dynamics simulation.

Results:

1. Disorder induces string-like defects in relative phase of layers, with endpoints being vortices. Strong enough disorder deconfine these vortices. Isolated vortices support low-energy, localized excitations which cause dissipation at low temperature. We call this a **string glass state**.
2. Large interlayer current depins strings from disorder. Breakdown of the resonance is thus a depinning phenomenon.

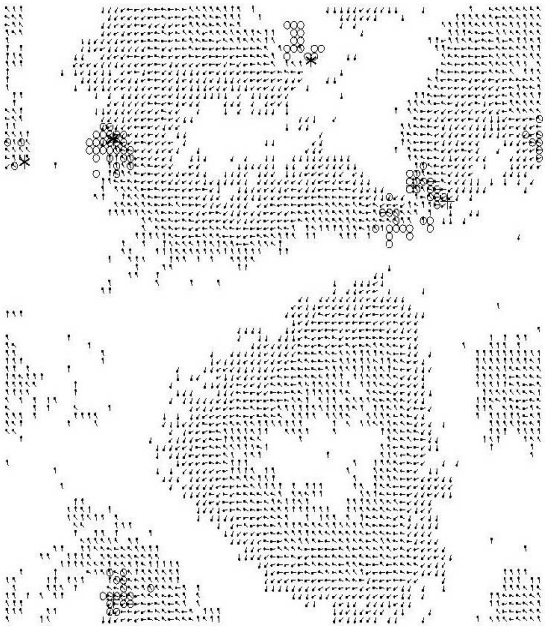
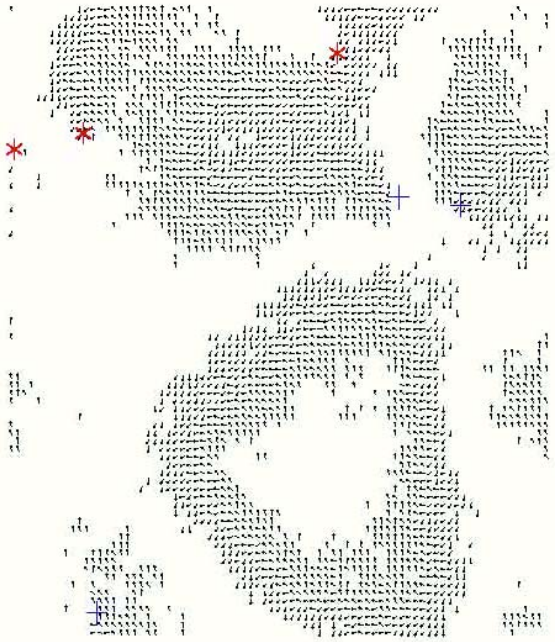


Figure: Typical configuration showing strings and vortices. Circles indicate regions of localized excitations.



Animation: Behavior of strings at high tunneling drive, illustrating their depinning and the onset of normal resistance.